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A STUDY OF ENERGY TRANSFER PROCESSES IN MOLECULAR LASERS

Interim Technical Report

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Interim Technical Report

A study of energy transfer processes in molecular lasers is being carried out in the Research Institute for Engineering Sciences at Wayne State University, under a grant from the U.S. Army Research Office in Durham, North Carolina. This document is an interim report on progress to date accomplished under this grant.

The main effort to date has been in modeling the kinetics of the $CO-N_2$ molecular laser. An extensive computer model has been devised, which can model the behavior of a mixture of two diatomic molecular gases, such as N_2 and CO, along with an added monatomic diluent, such as He, and electrons. Up to 30 vibrational levels are separately accounted for in each of the diatomic constituents. To date, the electron distribution has been described by an effective electron temperature, but work is presently underway to incorporate the explicit solution of the Boltzmann Equation into the code, using the formulas expressed by Frost and Phelps (Physical Review 127, 1621(1962)).

The computer model yields the temporal development of the laser pulse from a $CO-N_2$ laser oscillator, or the evolution of the large signal gain in an amplifier. Spontaneous emission histories are predicted for the fundamental and overtone bands of CO. These synthetic spectra are to be measured in the laboratory, and compared with the model predictions. With the addition of the Boltzmann Equation subroutine, the model will provide a complete and flexible description of the $CO-N_2$ laser, under a wide variety of operating conditions.

In the laboratory, a mode-controlled oscillator and glow discharge amplifier have been designed. It is anticipated that these will be constructed over the summer. Preliminary measurements have been made on an unstabilized oscillator, to test and develop procedures for recording sidelight spectra.

An interferometric method has been applied to monitoring the temperature distribution in the laser. A list of personnel contributing to this research effort, and publications and reports, appended.

PERSONNEL CONTRIBUTING TO RESEARCH EFFORT

Faculty and staff

Professor A.J. Glass - Principal Investigator

Professor E.R. Fisher

Professor R. Marriott

Professor A. Lightman

Dr. J.B. Atkinson - Research Associate

Students

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REPORTS & PUBLICATIONS

R. Marriott, "Molecular Collision Cross Sections and the Effect of Helium on Vibrational Relaxation in Carbon Monoxide". RIES Report 71-21, presented at VIIth ICPEAC, Amsterdam, 1971.

R. Marriott and G. Kindt, "Molecular Collision Cross Sections and the Effect of Argon on Vibrational Relaxation in Nitrogen". RIES Report 71-22

E.R. Fisher and G. Abraham, "Vibrational Excitation Rate Coefficients for N_2 and CO by Electrons," RIES Report 71-31, presented at the 1971 Gaseous Electronics Conference.

E.R. Fisher and G. Abraham, "Modeling of a Pulsed CO/N_2 Molecular Laser System," RIES Report 71-39, accepted for publication in J. App. Phys., October, 1972.

A.J. Glass, "Molecular Two-Photon Processes in Light Propagation," RIES Report 72-42, invited paper presented at Steamboat Springs Conference on Laser Physics, January 1972.

E.R. Fisher and G. Abraham, " CO Pulsed Laser Model," paper presented at 3rd Conference on Chemical and Molecular Lasers, St. Louis, May 1972.